University of Colorado
Center for Human Simulation
NGI Phase II NLM Contract

Abstract

Visible Human type data, colored pictures from cryosectioned anatomy, can be the foundation for high fidelity virtual anatomy, which has the potential to revolutionize all anatomy dependent medical training. But to create models that approach the potential of the data requires a great amount of work and innovation. We, at the University of Colorado Center for Human Simulation (CHS), have spent the last ten years refining Visible Human data to reach its potential. The steps go from segmenting and classifying the digital data through the creation of polygonal models with full resolution texture maps for real-time display. Our NGI effort focused on the creation of an authoring tool for building curriculum from the resulting models.

Virtual anatomy is a moving target involving:

- Constantly Improving Segmentation
- Continued Diversity (Gender, Age, Race and Body Habitus)
- Improving Resolution and Tissue Contrast
- Adding Pathology, Functionality, Physiology

The Next Generation Internet is a powerful device for serving this dynamic database to healthcare professionals worldwide. By serving the virtual anatomy from a single source, we can provide the users with immediate access to the evolving models.

We call the major result of our effort, the Explorable Virtual Human (EVH). The EVH is an authoring and display tool for delivering virtual anatomic curriculum over the internet. The EVH requires high-bandwidth to move the models, but because the rendering is all done locally, it is highly tolerant of latency and other instantaneous interruptions such as packet loss, making it practical for the NGI of today and the near future.

The EVH displays text, audio, video, and Interactive Anatomic Animations (IAA). IAAs are real-time 3-D animations based on virtual anatomy. To the student, they first look like animations. However, because the models are actually resident on their machine, they are able to take control of the models to produce their own motion and elements in the scene. The ability to author and display IAAs is a unique feature and a major strength of the EVH.

To create a typical page using the EVH, the author selects the anatomic structures that he or she wishes to display. Then, using a “what you see is what you get” paradigm, the author creates motion of the chosen scene. At any time during the editing, the author can choose to change the position and orientation, transparency, highlighting, or visibility of any object. We also developed the ability to 3-D surface paint the structures and create associated questions. The result is what we call an IAA. In parallel, the author can create

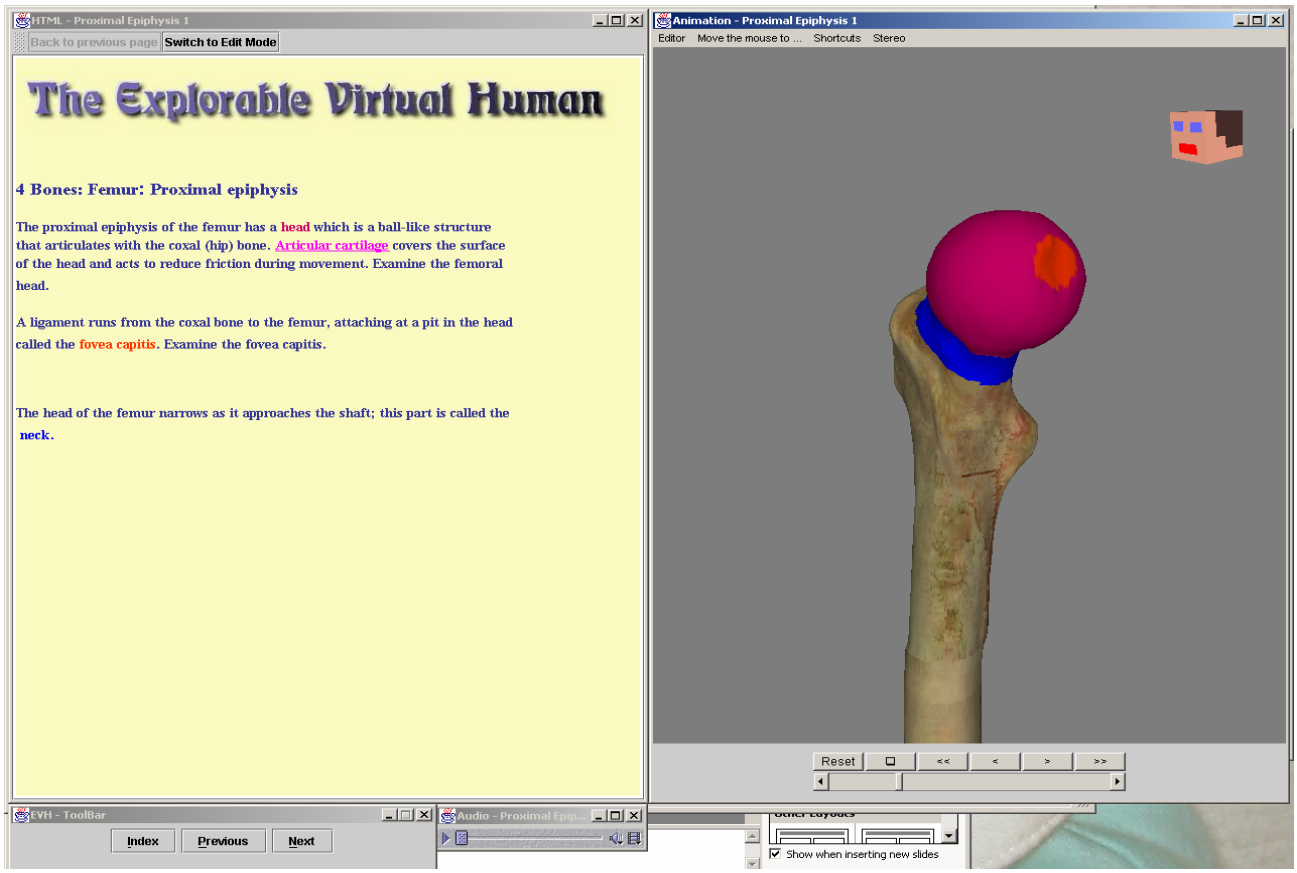
associated text and audio or import video to complete the page. An indexed hierarchy of pages makes up a lesson. The figure below shows text on the left and an IAA on the right. The neck, head, and fovea capitus of the femur are shown highlighted with 3-D surface painting.

We also developed techniques to include soft-tissue deformation in addition to affine transforms. Generally, the soft-tissue deformation is calculated offline but then can be displayed in real-time by the IAA.

We added the ability to feel the IAAs using haptic devices. For this we developed an interface between the JAVA side and native C++ code. This method allows us to utilize existing drivers and software, including GHOST (from SenseAble Technologies, Woburn, MA), as well as our own well-developed haptics algorithms.

In response to an initial phase II proposal reviewer request to include a surgical simulation component, we developed a Hardware Controlled Knee Joint (HCKJ) as an input device to an arthroscopy simulator. The HCKJ gives the students an artificial leg that they can manipulate to produce flexion, tibia rotation, and varus/valgus forces. The HCKJ measures each of these and provides the information to the display. The HCKJ is in its second incarnation since this effort and will serve as the input device for a diagnostic arthroscopy simulator being developed in partnership with the American Academy of Orthopaedic Surgeons with SBIR support from the National Institute of Arthritis and Musculoskeletal and Skin Diseases (2 R44 AR46935-03)

During the course of this contract we used the EVH to convey complex 3-D concepts to varying specialties. Faculty from the University of Colorado at Boulder, Red Rocks Community College, and the University of Colorado School of Medicine, assisted by an education specialist, utilized the EVH to design and display knee anatomy curriculum at their facilities. The resulting curriculum was positively reviewed by the Alliance for Technology, Learning, and Society (ATLAS) and very well received by the students and teachers alike. We used the EVH to help explain knee kinematics relative to total knee arthroplasty in a scientific exhibit that won top prize at the annual meeting of the American Academy of Orthopaedic Surgeons. We also used the EVH to teach urologists the relevant anatomy for inserting a needle for stimulation of the S-3 nerve. This later developed into a simulator for the procedure. A derivative of the EVH was used to create an Interactive Atlas that allows anyone with a fast Internet connection to make arbitrary oblique slices through the Visible Human male. The Interactive Atlas is part of a Center for Human Simulation effort to teach planar anatomy relevant to ultrasound to GI and cardiac physicians. It can be found at www.visiblehumanexperience.com. We recently combined the Interactive Atlas with a haptic device to create a realistic neurosurgery simulator.


HTML - Proximal Epiphysis 1
Back to previous page
Switch to Edit Mode
The Explorable Virtual Human
4 Bones: Femur: Proximal epiphysis
The proximal epiphysis of the femur has a head which is a ball-like structure that articulates with the coxal (hip) bone. Articular cartilage covers the surface of the head and acts to reduce friction during movement. Examine the femoral head.
A ligament runs from the coxal bone to the femur, attaching at a pit in the head called the fovea capitis. Examine the fovea capitis.
The head of the femur narrows as it approaches the shaft; this part is called the neck.
Animation - Proximal Epiphysis 1
Editor
Move the mouse to ...
Shortcuts
Stereo
Reset
<<
<
>
>>
EVH - ToolBar
Index
Previous
Next
Audio - Proximal Epip...
Show when inserting new slides